Royal HaskoningDHV
Enhancing Society Together

VATTENFALL

Norfolk Vanguard Offshore Wind Farm

Outline Offshore Operations and Maintenance Plan (Track Changes)

Applicant: Norfolk Vanguard Limited
Document Reference: 8.11 (version 2)
Deadline 7

Date: 02 May 2019
Author: Royal HaskoningDHV

Photo: Kentish Flats Offshore Wind Farm

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
20/04/19	01	First draft of Revision 2	GK	GK	
30/04/19	02	Second draft of Revision 2	GK	GK	
01/05/19	03	Third draft of Revision 2	GK	GK	
02/05/19	04	Deadline 7 submission	GK	GK	RS

Table of Contents

Glossary

DCO	Development Consent Order
DML	Deemed Marine Licence
ES	Environmental Statement
MMO	Marine Management Organisation
MW	Megawatt
NV East	Norfolk Vanguard East
NV West	Norfolk Vanguard West
O&M	Operation and Maintenance
OOMP	Offshore Operation and Maintenance Plan
OWF	Offshore Wind Farm
UPS	Uninterruptible Power Supply
VWPL	Vattenfall Wind Power Limited

Terminology

Array cables	Cables which link the wind turbines and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link the offshore electrical platforms
Landfall	Where the offshore cables come ashore at Happisburgh South
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead
Offshore cable corridor	The corridor of seabed from the Norfolk Vanguard OWF sites to the landfall site within which the offshore export cables would be located.
Offshore electrical platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which bring electricity from the offshore electrical platform to the landfall.
Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the offshore cable corridor
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area under the Energy Act 2004.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
The Applicant	Norfolk Vanguard Limited
The OWF sites	The two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West
The project	Norfolk Vanguard Offshore Wind Farm, including the onshore and offshore infrastructure

1 INTRODUCTION

1.1 Background

1. Norfolk Vanguard Limited ('the Applicant' an affiliate company of Vattenfall Wind Power Limited (VWPL)) is seeking a Development Consent Order for Norfolk Vanguard, an offshore wind farm (OWF) in the southern North Sea.

2. The OWF comprises two distinct areas, Norfolk Vanguard East (NV East) and Norfolk Vanguard West (NV West) ('the OWF sites'), within which wind turbines, associated platforms and array cables will be located. The offshore wind farm will be connected to the shore by offshore export cables installed within the offshore cable corridor from the wind farm to a landfall point at Happisburgh South, Norfolk. From there onshore cables would transport power over approximately 60km to the onshore project substation at Necton, Norfolk. A full project description is given in the Environmental Statement, Chapter 5 Project Description.

3. Norfolk Vanguard is located approximately 47km from the closest point the Norfolk Coast. NV East covers an area of approximately 297km^2 and NV West covers an area of around 295km^2.

4. Once built, Norfolk Vanguard would have a capacity of up to 1800MW, with the offshore components comprising:

   - Up to 200 wind turbines;
   - Up to two offshore electrical platforms;
   - Up to two accommodation platforms;
   - Up to two met masts;
   - Up to two LiDAR;
   - Up to 600km array cables;
   - Up to 150km inter-connector cables; and
   - Up to 400km export cables (in two trenches of approximately 100km length each).

~~5. Norfolk Vanguard Limited is currently considering constructing the project in either a single phase or as two phases (up to a maximum of 1800MW). The layout of the wind turbines will be defined post consent but will be based on the following maxima:~~

   - ~~1800MW in NV East, 0MW in NV West; or~~
   - ~~0MW in NV East, 1800MW in NV West.~~

~~6. Any other potential layouts that are considered up to a maximum of 1800MW (e.g. 1,200MW in NV West and 600MW in NV East; 600MW in NV West and 1,200MW in~~

~~NV East; or 900MW in NV West and 900MW in NV East) lie within the envelope of these scenarios.~~

~~7.~~5. Construction of the project under either approach would be anticipated to commence between 2020 and 2021 for the onshore works, and around 2024 for the offshore works.

1.2 Purpose of this Document

~~8.~~6. This outline Offshore Operation and Maintenance Plan (OOMP) has been drafted with specific reference to the interpretation of the definition of "maintain" within the Development Consent Order (DCO).

~~9.~~7. The purpose of this document is to provide an outline of reasonably foreseeable offshore maintenance activities and the broad approach to be taken for each activity.

~~10.~~8. The final OOMP would be prepared following post-consent detailed design as required under DCO Schedule 9 and 10 condition ~~[~~14(1)(j)] and Schedule 11 and 12 condition [9(1)(j)~~]~~, which states:

"An offshore operations and maintenance plan, in accordance with the outline offshore operations and maintenance plan, to be submitted to the MMO at least ~~four~~six months prior to commencement of operation of the licensed activities and to provide for review and resubmission every three years during the operational phase."

~~11.~~9. The OOMP will be developed at least ~~four~~ six months prior to construction for each Deemed Marine Licence (DML), which would include details of the:

- Operation and Maintenance (O&M) requirements of the project, including all equipment, structures and associated infrastructure, in accordance with design and manufacturer recommendations;
- Operational health, safety and environment management;
- Accessibility and constraints;
- Logistical set up of the O&M base;
- O&M staff requirement, including numbers and skills;
- Spare parts and availability; and
- Planning of scheduled and unscheduled maintenance

~~12.~~10. Norfolk Vanguard Limited has assessed the following reasonably foreseeable offshore maintenance activities within the Environmental Statement (ES):

- Scheduled Maintenance:
  - Each turbine will require regular servicing

- Scheduled maintenance would be undertaken from vessels (e.g. Service Offshore Vessel, Crew Transfer Vessel etc.) or helicopters.

- Unscheduled Maintenance:
  - During the operational period it is anticipated that unscheduled maintenance activity may be required to deal with fault finding and repairs of the turbines, cables and associated offshore infrastructure.
  - Unscheduled maintenance would be undertaken from vessels such as jack-up barges, Service Offshore Vessels, Crew Transfer Vessels etc., or helicopters.

11. Appendix 1 of this document outlines the estimated frequency and seabed footprints of the maintenance activities. This has been updated and resubmitted at Deadline 7 (02 May 2019) of the Examination to correct an error identified in the Errata report (document reference Pre-ExA; Errata; 9.4) and to clarify which maintenance works would require consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs) in response to the following comment by Natural England in their relevant representation:

Natural England notes that condition 14 (j) requires the submission of an operations and maintenance plan every 3 years and that based on the in-principle operations and maintenance plan all activities permitted (including cable repair and reburial) would not require a consultation. Given the significant concerns related to the designated sites and the presence of annex I habitat along various areas of the export cable, Natural England does not consider it appropriate for such works to proceed without further consideration and updated assessments. Natural England would like to engage with the applicant and the MMO on potential changes to the Outline Operations and Maintenance Plan and the DML conditions to ensure that important habitats are not unduly impacted during the operations phase of the project.

12. In addition, Appendix 1 has been updated to reflect that any new cable protection required during maintenance would be subject to additional licensing, in response to comments from the MMO in their Deadline 6 submission.

~~13.~~

13. Maintenance activities relating to the export cables within the section of the offshore cable corridor where it overlaps with the Haisborough, Hammond and Winterton Special Area of Conservation (SAC) are outlined in Appendix 1 for completeness, however these activities are considered separately in the Outline Haisborough, Hammond and Winterton SAC Site Integrity Plan (SIP) (document reference 8.20) and must be agreed with the MMO in consultation with relevant

Statutory Nature Conservation Bodies in accordance with Condition 9(1)(m) of DCO Schedules 11 and 12. Maintenance works within the Haisborough, Hammond and Winterton SAC will therefore not be considered in the final Operation and Maintenance Plan.

14. The operational impacts are assessed in each offshore technical chapter of the Environmental Statement; Chapter 8 Marine Geology, Oceanography and Physical Processes; Chapter 9 Marine Water and Sediment Quality; Chapter 10 Benthic Ecology; Chapter 11 Fish and Shellfish Ecology; Chapter 12 Marine Mammal Ecology; Chapter 13 Offshore Ornithology; Chapter 14 Commercial Fisheries; Chapter 15 Shipping and Navigation; and Chapter 18 Infrastructure and Other Users.

2 DISCHARGING THE CONSENT CONDITION

2.1 Activity list during the Operations and Maintenance Phase

15. The list of activities to be undertaken during the O&M phase is provided as Appendix 1. This O&M list is a live document which will be updated and agreed with the Marine Management Organisation (MMO) as required.

16. For each activity, a 'traffic light system' will be used to provide clarity as to those activities that can be carried out under the existing DMLs.

- **Green** indicates that an additional marine licence is not required, however notification should be provided to the MMO on works being undertaken;
- **Amber** indicates that an additional marine licence may be required if proposed works exceed those assessed within the Environmental Statement or described within the DCO; or
- **Red** indicates that an additional marine licence could be required dependant on the type of works to be undertaken.

17. Additional activities not outlined in this schedule (including Appendix 1) may, if relevant, require future consents such as a Marine Licence under the Marine and Coastal Access Act 2009. Such activities will be discussed with the MMO prior to undertaking if appropriate.

APPENDIX 1: OPERATIONS AND MAINTENANCE LIST

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Wind turbines (topside)						
Annual wind turbine maintenance	Generation	Assessed in the ES	Assessed in the ES within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. There are a number of potential maintenance strategies for the wind farm which will be determined by the final design of the wind farm and procurement of the maintenance contractors. The wind farm could be maintained from shore using a number of varying Operation and Maintenance (O&M) vessels (e.g. crew transfer vessels, supply vessels) possibly supported by helicopters. Alternatively, the wind farm could be maintained primarily from an offshore base (e.g. an accommodation vessel (Service Offshore Vessel) or a fixed offshore accommodation platform), with transfer vessels or helicopters also used to transfer personnel to or from turbines and platforms.	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 13 Offshore Ornithology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	No	No
Wind turbine troubleshooting	Generation	Assessed in the ES			No	No
Wind turbine repair	Generation	Assessed in the ES			No	No
Blade inspection	Generation	Assessed in the ES			No	No
Blade and hub repair	Generation	Assessed in the ES			No	No
Blade replacement	Generation	Assessed in the ES			No	No
Transition piece repair	Generation	Assessed in the ES			No	No
Transition piece maintenance	Generation	Assessed in the ES			No	No
Transformer replacement	Generation	Assessed in the ES			No	No
Gearbox repair and replacement	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Generator replacement	Generation	Assessed in the ES	Typical maintenance activities would include; general wind turbine service; oil sampling / change; UPS (uninterruptible power supply)-battery change; service and inspections of wind turbine safety equipment, nacelle crane, service lift, HV system, blades. Although it is not anticipated that large components (e.g. wind turbine blades or substation transformers) would frequently require replacement during the operational phase, the failure of one of these components is possible. Should this be required, large jack-up vessels may need to operate continuously for significant periods to carry out these major maintenance activities. Maximum of two locations visited by one jack-up vessel to the Norfolk Vanguard site per day during operation. Jack up vessel with a footprint of 792m^2 which would lead to a total area of up to 0.58km^2 per year (assumes large jack up with up to six legs). Indicative quantities of oils and fluids per turbine: • Gearbox oil: 1000 litres • Hydraulic oil: 1000 litres		No	No
Paint and repair		Assessed in the ES			No	No
J-Tube and ladder cleaning	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
			• Coolant systems: 1000 litres • Yaw/pitch motor oil: 20 litres • Transformer oil: 1500 litres • Yaw and motors: not determined			
Cables outside the Haisborough Hammond and Winterson SAC						
Additional cable laying	Generation and Transmission	Parameters in the DML not to be exceeded	During the life of the project, cable repairs may be required and periodic inspections will be undertaken. Periodic surveys would also be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. In most cases a failure would lead to the following operations: • Vessel anchor placement (150m^2 footprint) • Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair; • Cutting the cable; • For array cables it may be preferable to lift a whole length of a cable between two turbines, of up to approximately 2km length; • Lifting the cable ends to the repair vessel;	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	No~~Alert the MMO - review current survey data for the new location~~	Yes
Cable inspection	Generation and Transmission	Assessed in the ES			No	No
New ~~C~~cable ~~burial using surface~~ protection	Generation and Transmission	~~Parameters in the DML not to be exceeded~~N/A			Yes~~Alert the MMO – No further action required~~	Yes
Replacement or addition to cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes
Cable re-burial	Generation and Transmission	Assessed in the ES			No~~Alert the MMO – No further action required~~	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable repair	Generation and Transmission	Assessed in the ES	• Jointing a new segment of cable to the old cable; • Lowering the cable (and joints) back to the seabed; and • Cable burial, where possible. ~~In most cases a failure would lead to the following operation: taking out the damaged part of the cable, cutting the cable, inserting a joint, bringing a new segment of cable and jointing the new segment with the old cable.~~ Worst case assumes: • Maximum of ~~5~~ 4 failures per year: o 2 x array cables (assume the whole length of an array cable is replaced – max length 6km based on turbine spacing) o 1 x Interconnector cables (assume a few hundred metres subject to repair) o ~~2~~ 1 x Export cables (assume 300 metres subject to repair) Cables can become exposed due to moving sand waves but also sometimes due to erosion of other soft/mobile sediment (not just sand waves). During the life of the project, periodic surveys would be required to ensure the cables		No~~Alert the MMO - No further action required~~	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
			remain buried and if they do become exposed, re-burial works would be undertaken. Post construction surveys in the initial 3-5 years are often dictated by the deemed marine license. ~~For array cables, assume~~ The worst case scenario for array cable re-burial is based on an estimate of ~~all~~ 25%~~sections~~ of the array cable every 5 years. For export cables, the aim would be to avoid requirement for re-burial by using pre-sweeping. A worst case scenario of reburial of up to 20km length per export cable pair is assumed. An estimated reburial length of 1 km at a time is assessed.			
Cables within the Haisborough Hammond and Winterson SAC (addressed in the Haisborough Hammond and Winterson SAC SIP, document 8.20)						
Additional cable laying	Generation and Transmission	Parameters in the DML not to be exceeded	During the life of the project, cable repairs may be required and periodic inspections will be undertaken. Periodic surveys would also be required to ensure the cables remain buried and if they do	Information to Support HRA Report (document 5.3)	No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable inspection	Generation and Transmission	Assessed in the ES	become exposed, re-burial works would be undertaken. In most cases a failure would lead to the following operation: • Vessel anchor placement (150m^2 footprint) • Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair; • Cutting the cable; • Lifting the cable ends to the repair vessel; • Jointing a new segment of cable to the old cable; • Lowering the cable (and joints) back to the seabed; and • Cable burial. While it is not possible to determine the number and location of repair works that may be required during the life of the project, an average estimate of one export cable repair every 10 years within the SAC is included in the assessment.		No	Yes
Cable burial using surface protection	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes
New cable protection	Transmission	N/A			Yes	Yes
Replacement or addition to cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable re-burial	Generation and Transmission	Assessed in the ES	Cables can become exposed due to moving sand waves but also sometimes due to erosion of other soft/mobile sediment (not just sand waves). During the life of the project, periodic surveys would be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. The aim would be to avoid requirement for any re-burial by using pre-sweeping at the installation stage to bury cables below the mobile sandwave. However a worst case scenario for reburial of up to 4km per cable pair within the SAC at approximately 5 year intervals has been assessed based on the worst case scenario that no pre-sweeping is undertaken during installation.		No	Yes
Cable repair	Generation and Transmission	Assessed in the ES			No	Yes
Wind Turbine, Metmast and Accommodation Platform Foundations						
Foundation inspection	Generation	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance.	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology;	No	No
Foundation repair	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
				ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.		
Foundation replacement	Generation	N/A	Replacement of a failed foundation is considered to be a highly unlikely event. Should such an occurrence take place then consent for the replacement of the failed foundation would be obtained from the MMO prior to commencement.	N/A	~~Discuss with the MMO~~Yes	Yes
Additional scour protection around foundations	Generation	Parameters in the DML not to be exceeded	Scour protection is included in the worst case scenario of 100% foundations requiring scour protection.	Maximum parameters included in construction phase: ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 9 Marine Water and Sediment Quality ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries.	~~Alert and discuss with the MMO~~No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in ~~ES~~the Application documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Offshore Electrical Platforms						
Inspections	Transmission	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. Offshore electrical platforms would typically require an average of 1 visit / week although this may be more during unscheduled maintenance.		No	No
General maintenance work, eg oil replacement, mechanical works etc	Transmission	Assessed in the ES			No	No
Switchgear replacement	Transmission	Assessed in the ES			No	No
Other						
Davit crane inspection	Generation	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. See worst case in terms of 'topside-related replacement, refurbishment and repair activities' for wind turbines.	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	No	No
Fuel replenishment to crew transfer vessel	Generation	Assessed in the ES			No	No
Re-fuelling of generator on the Sub-station	Generation	Assessed in the ES			No	No
Grout and corrosion works	Generation	Assessed in the ES			No	No
Crane transfers from vessel to either WTG's or to quayside O&M Building or vice-versa	Generation	Assessed in the ES			No	No